

# DYNAMO Webinar Series

*Dynamics of the Madden-Julian Oscillation Field Campaign*

## Ship-based measurement of air-sea fluxes, the atmospheric boundary layer, and clouds during MJO development

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Wednesday, May 28 2:30pm

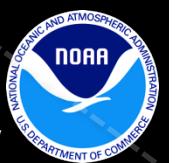


<sup>1</sup>Oregon State University

<sup>2</sup>NOAA Earth System Research Laboratory



Climate Variability & Predictability

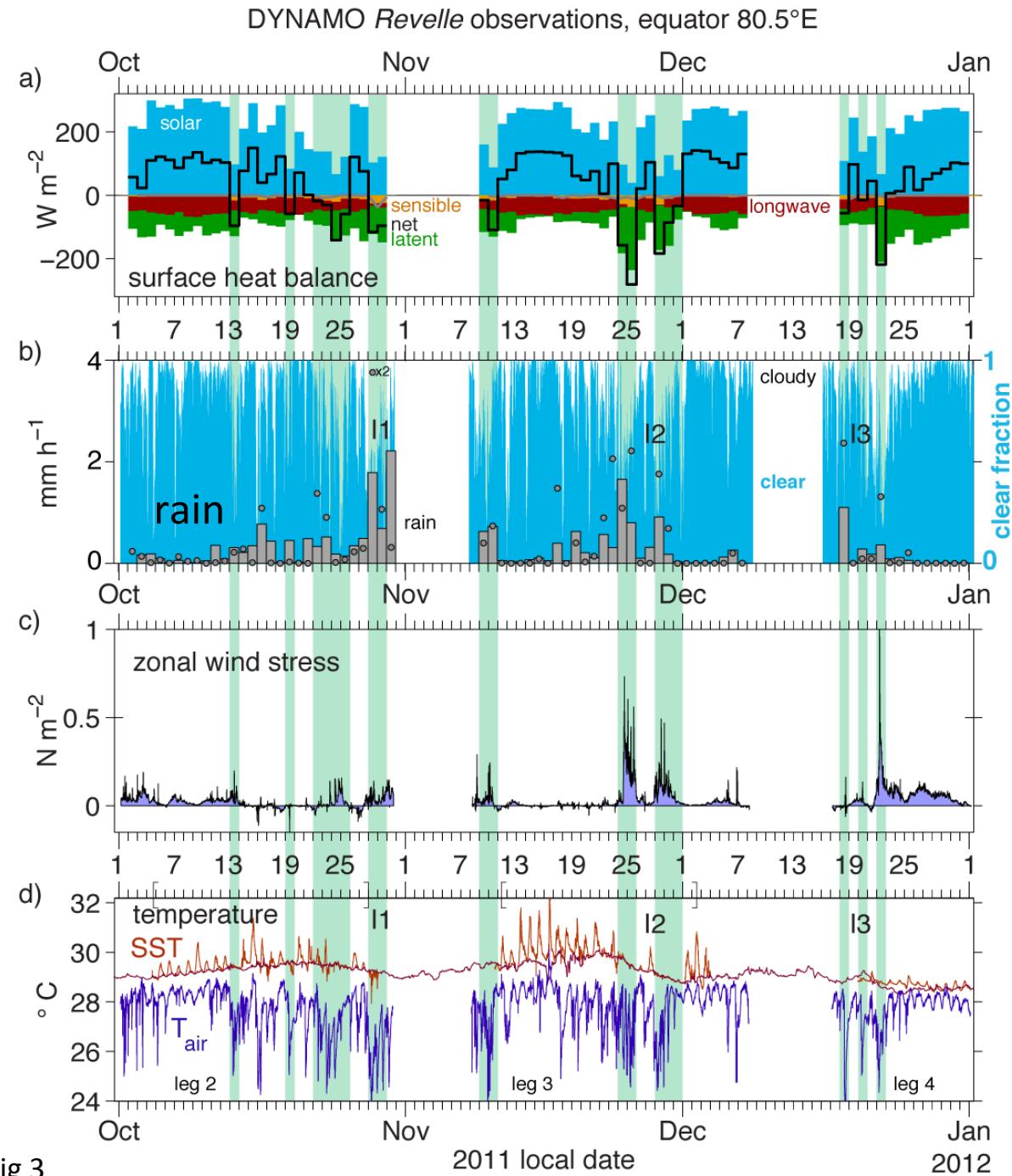


# Equatorial air-sea interaction in DYNAMO

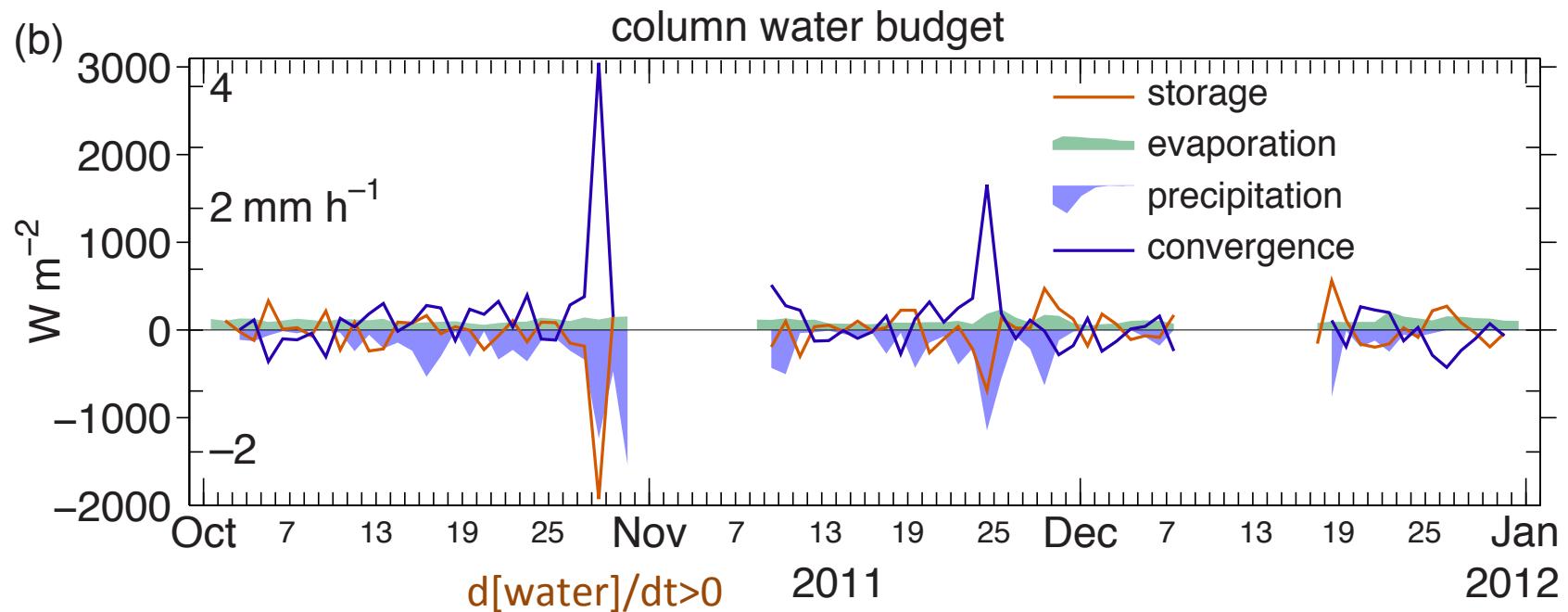
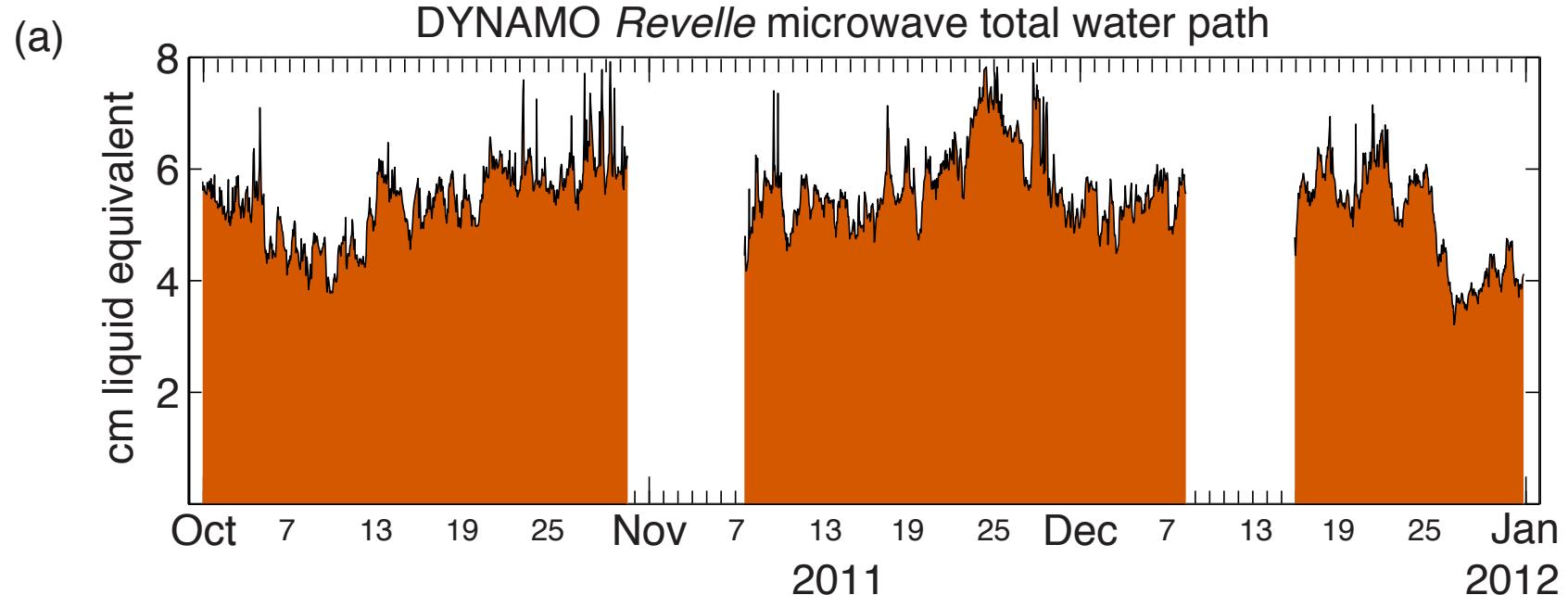
1. Data:
  - DYNAMO (2011-2012, *Revelle* at equator, 80.5°E)
  - TOGA-COARE (1992-1993, equator 155°E)
  - TropFlux 1x1 gridded 27-year (Praveen Kumar 2013)
2. Heat transfer through the air-sea interface is related to MJO convection.
3. Does evaporation anomaly explain precipitation?
4. Composite **MJO** (103 intraseasonal events)
  - Phase of surface air-sea response
  - longitude: COARE vs. DYNAMO
5. Compare MJO vs. Kelvin waves

MJO convective and stress anomalies cool SST.

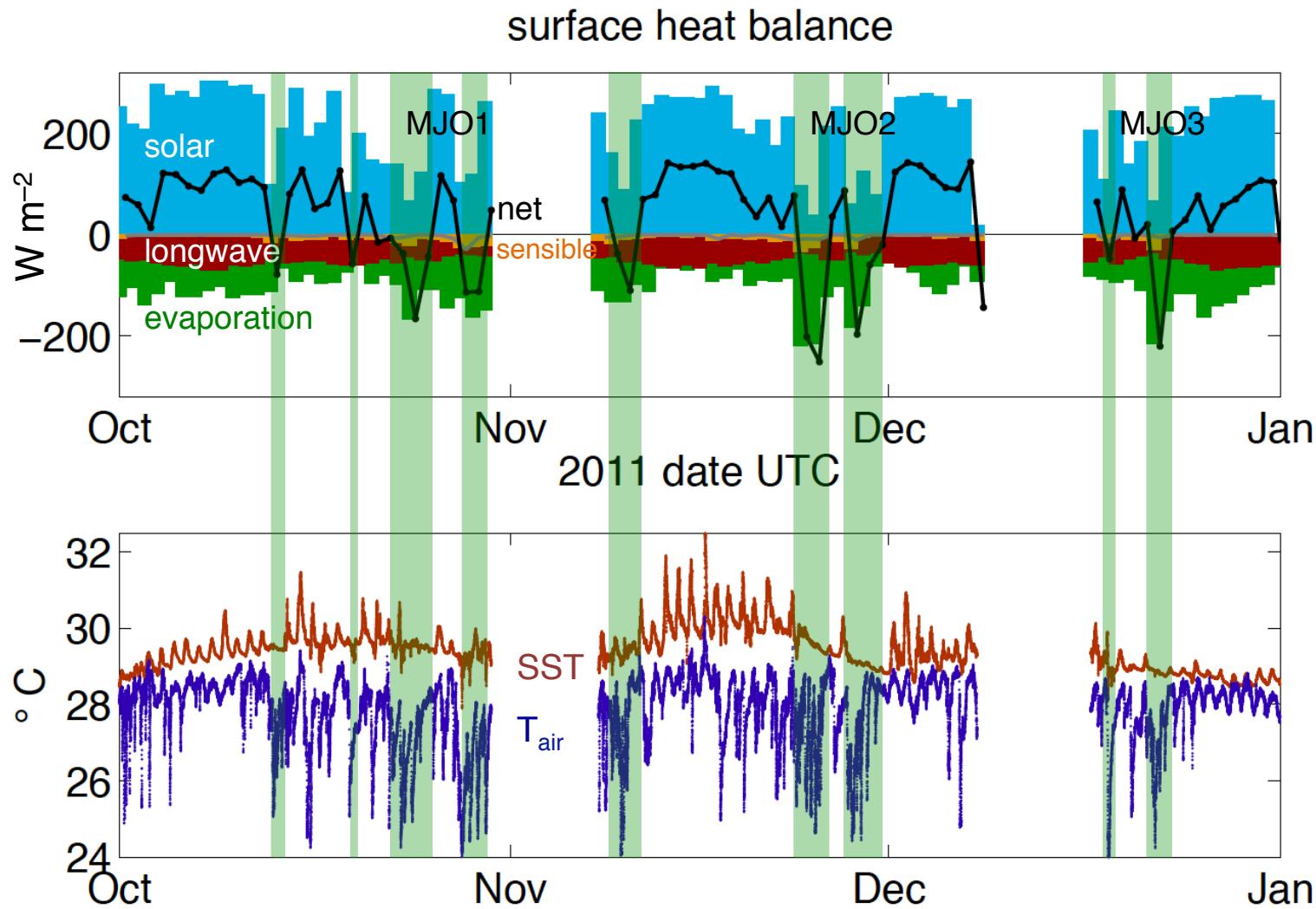
Does the ocean affect intraseasonal atmospheric convection?



cf. TOGA COARE, Anderson et al. 1996 Fig 3

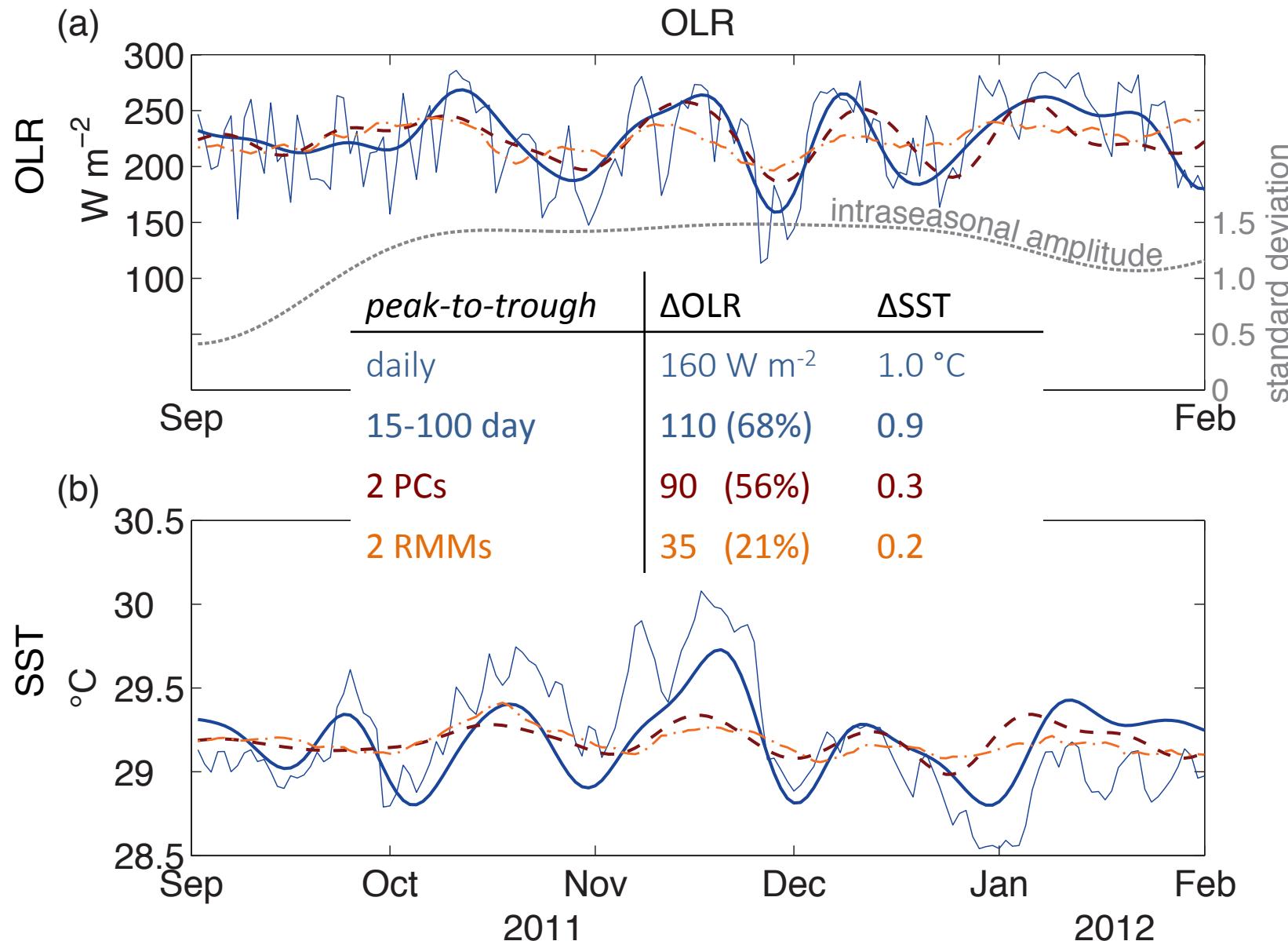


# Intraseasonal SST and atmospheric temperature

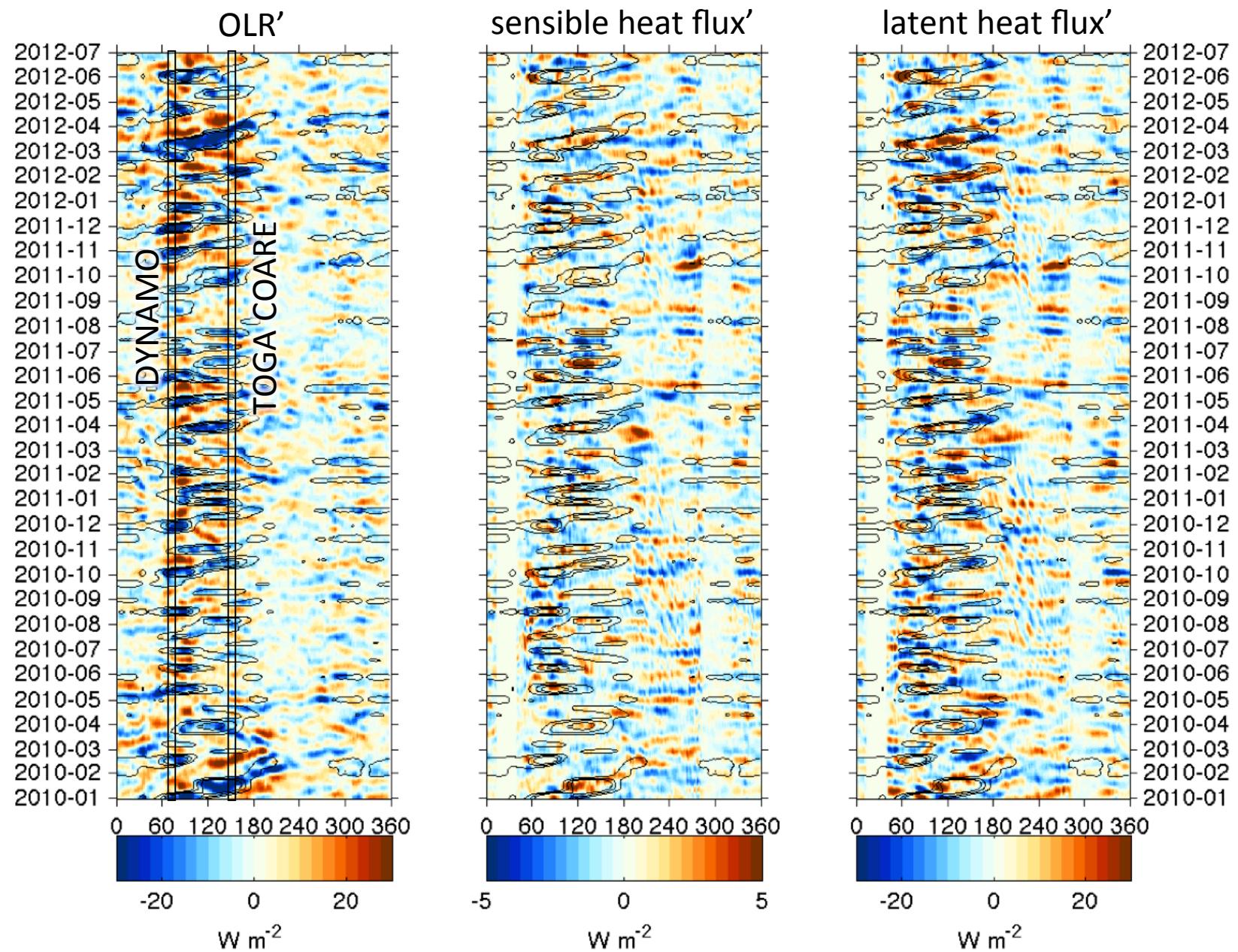


## How do tropical intraseasonal indices sample variability observed in DYNAMO?

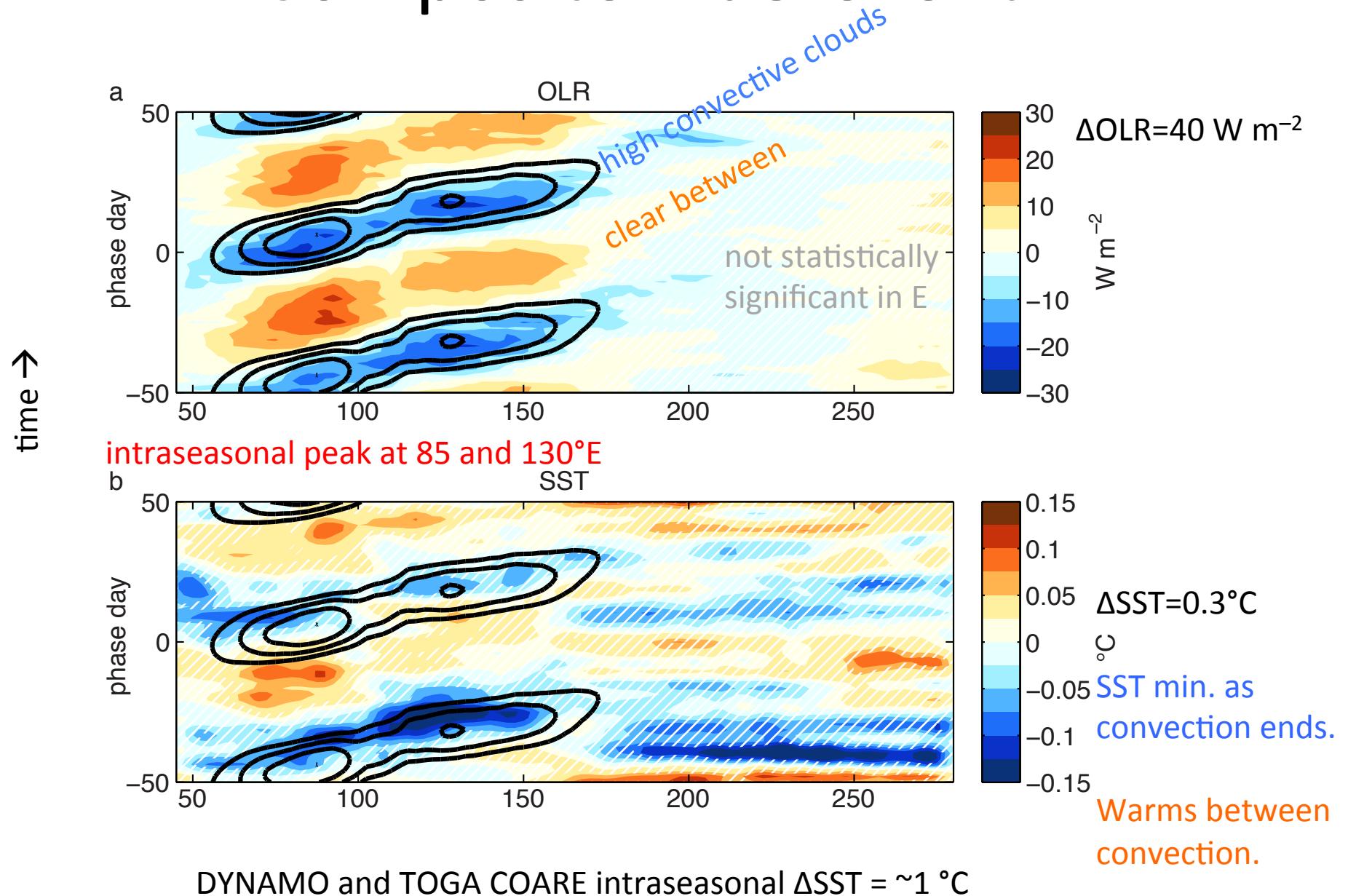
DYNAMO 2011-2012, 80.5°E, 0°N



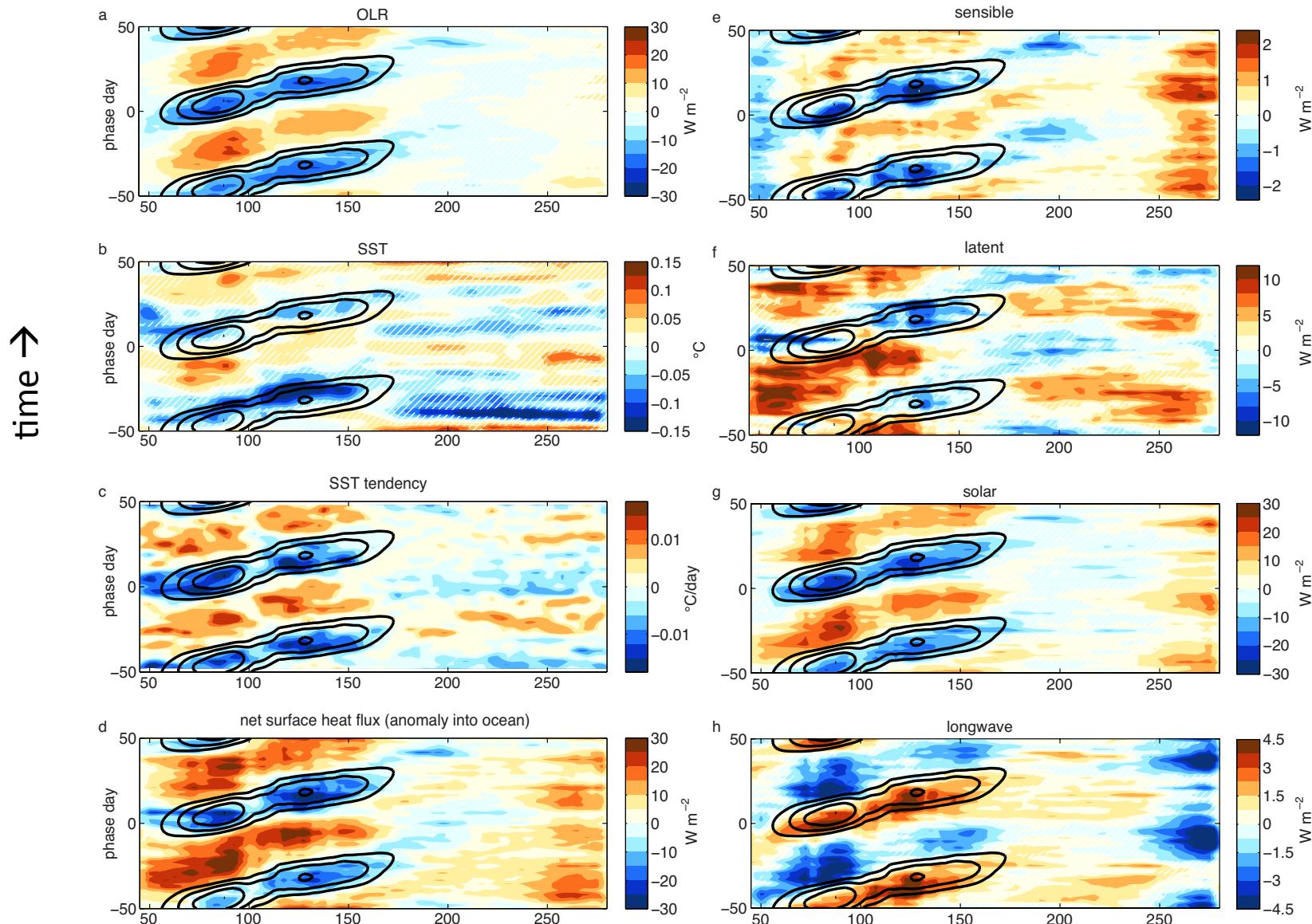
# composite surface anomalies onto MJO phase



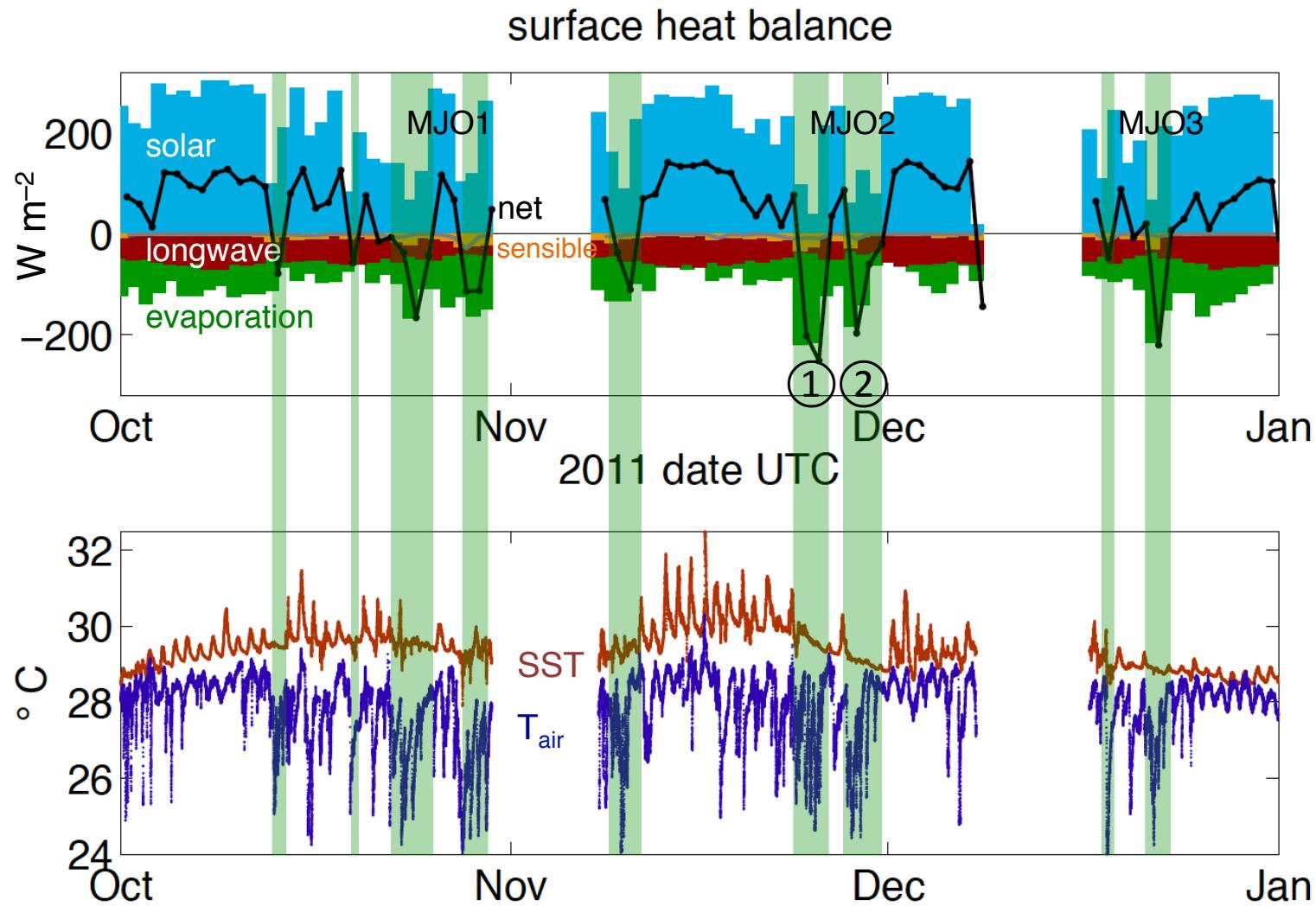
# Composite MJO event



# MJO composite air-sea interaction

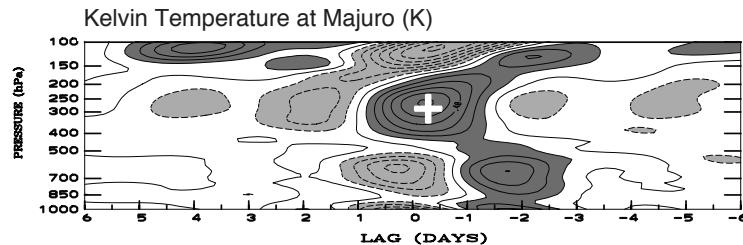


# double structure of MJO2

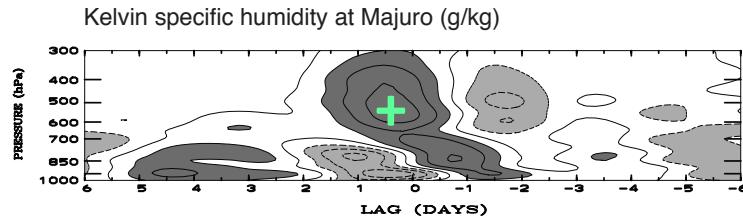


# November 2011 convective pulses resemble Kelvin waves

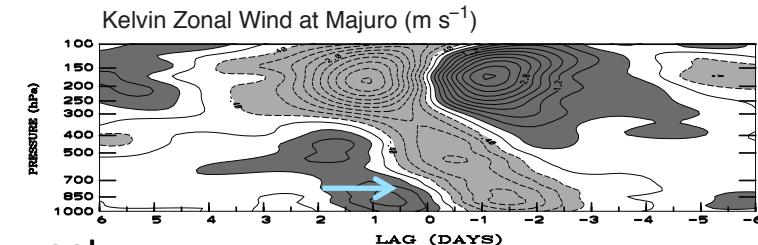
Kiladis et al. (2009) composite



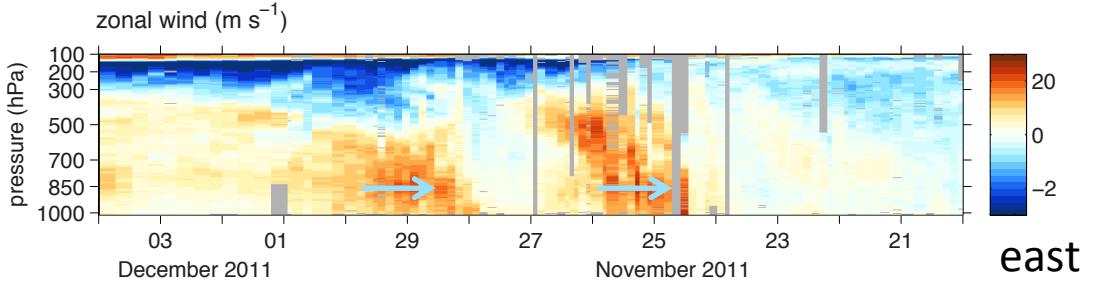
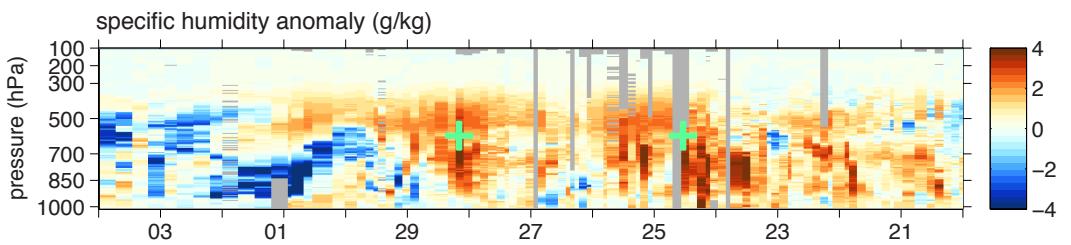
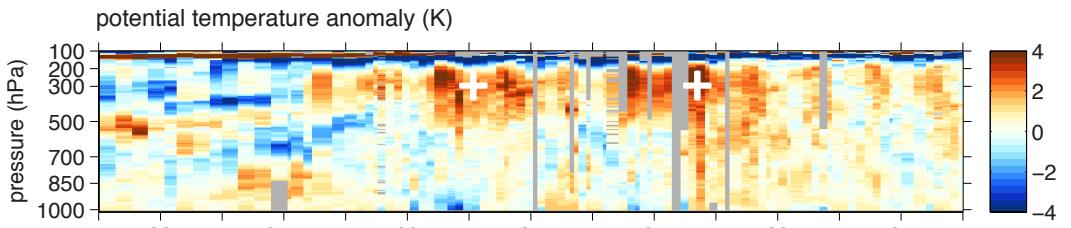
- Heating aloft leads humidity. (midlevel heating weak)



- Zonal wind lags and leans westward.

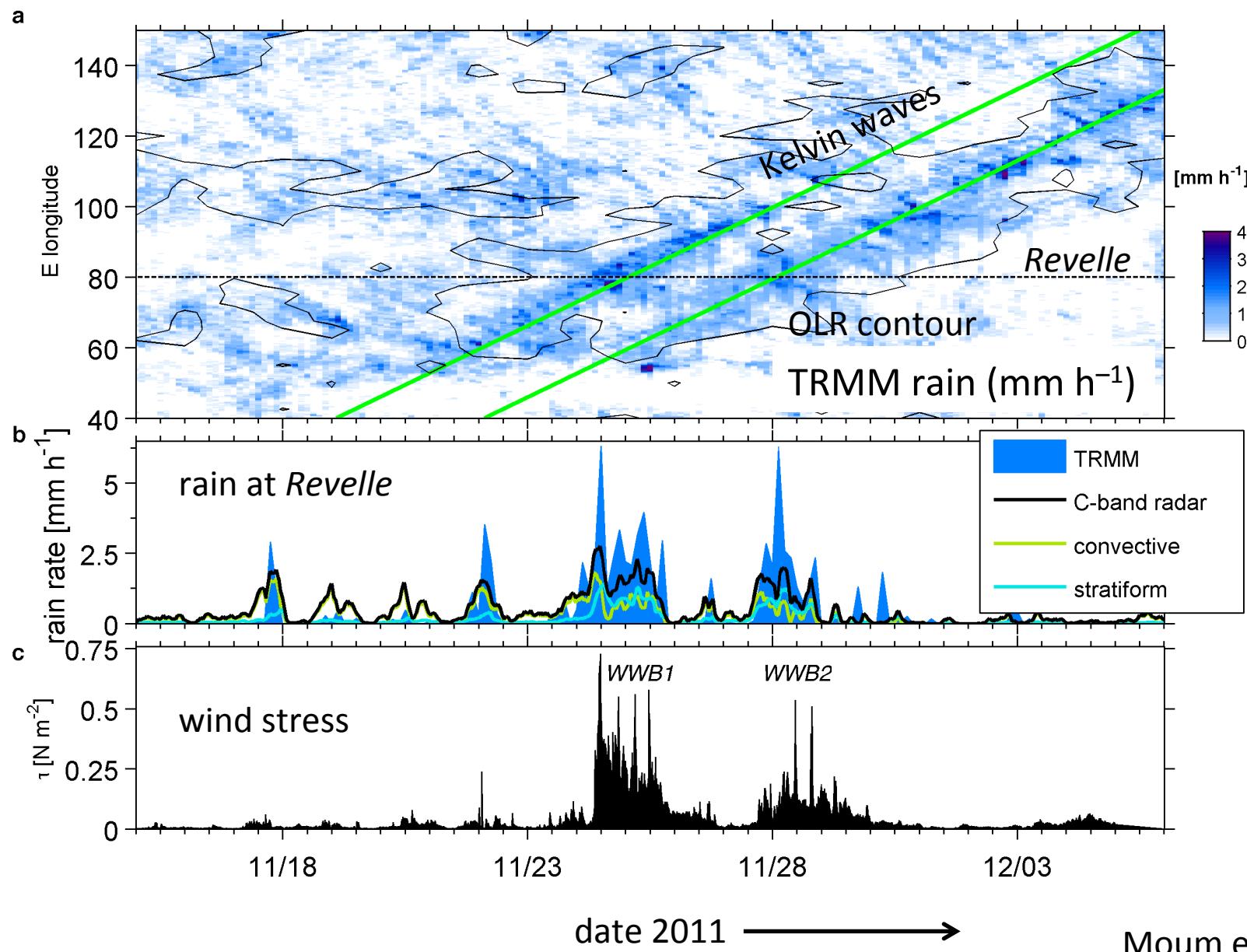


DYNAMO November MJO

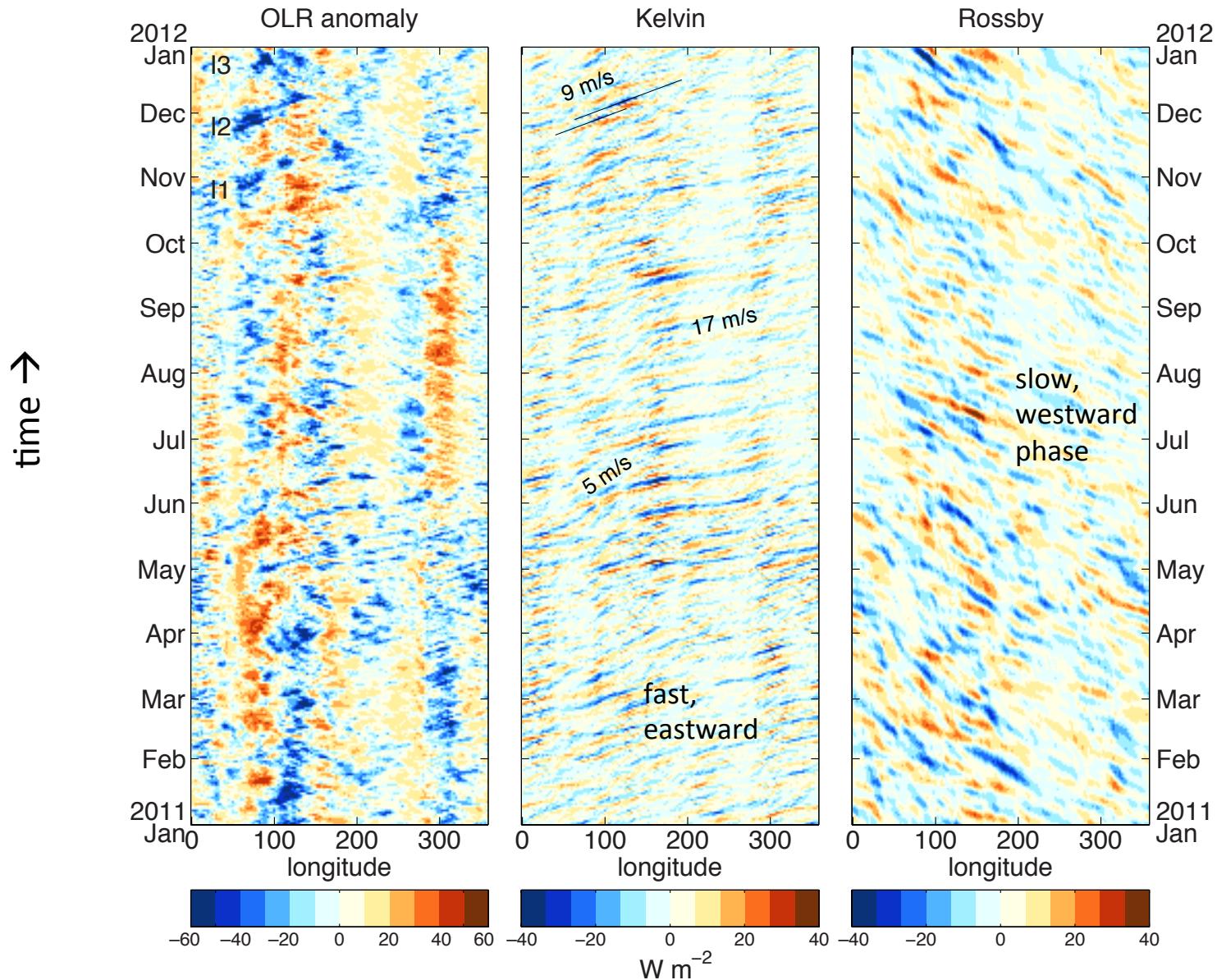


time ←

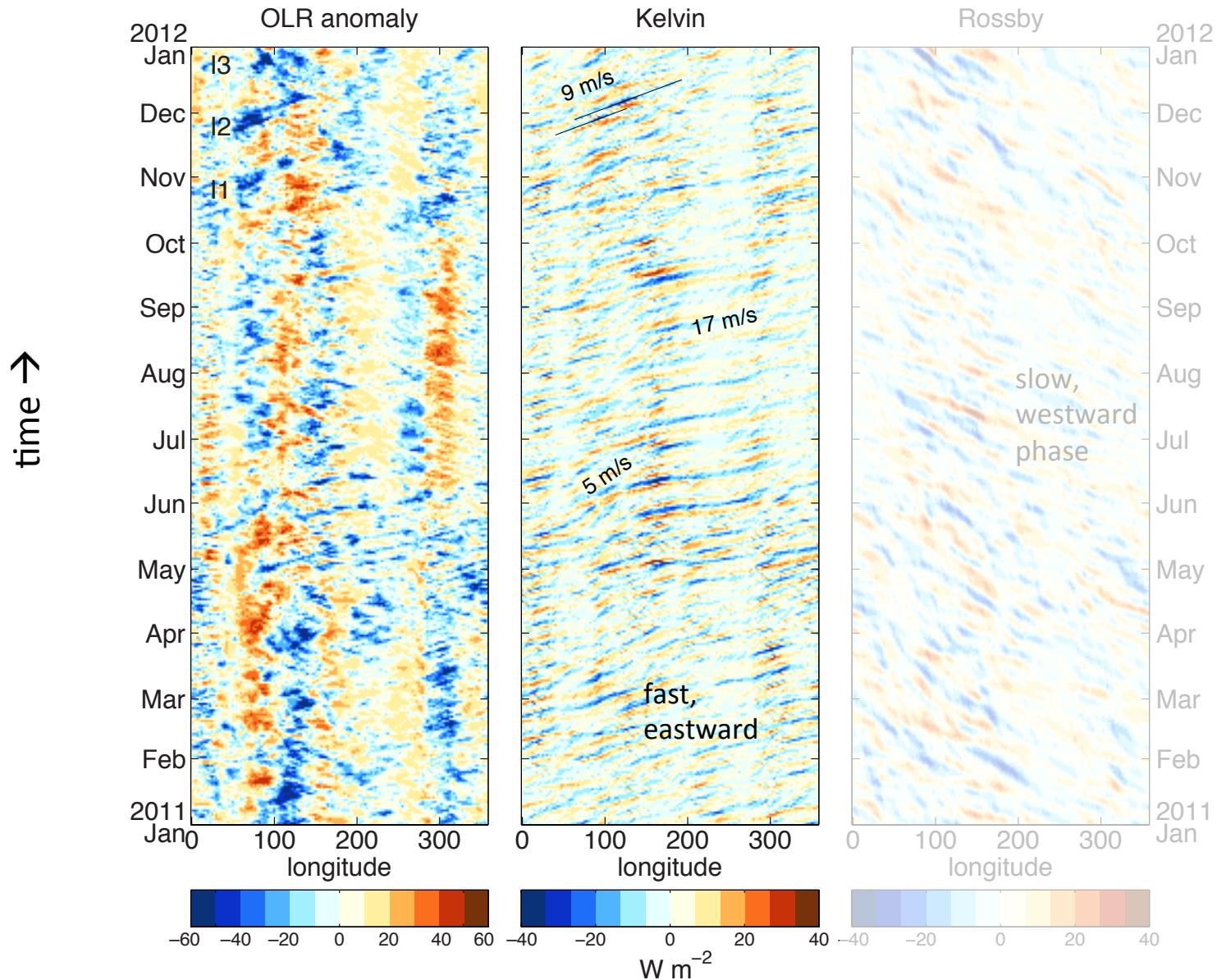
# Two convectively-coupled Kelvin waves in MJO2



# Kelvin and Rossby waves separated in wavenumber-frequency space



# Kelvin and Rossby waves separated in wavenumber-frequency space



# Composite on Kelvin and MJO phase of OLR'

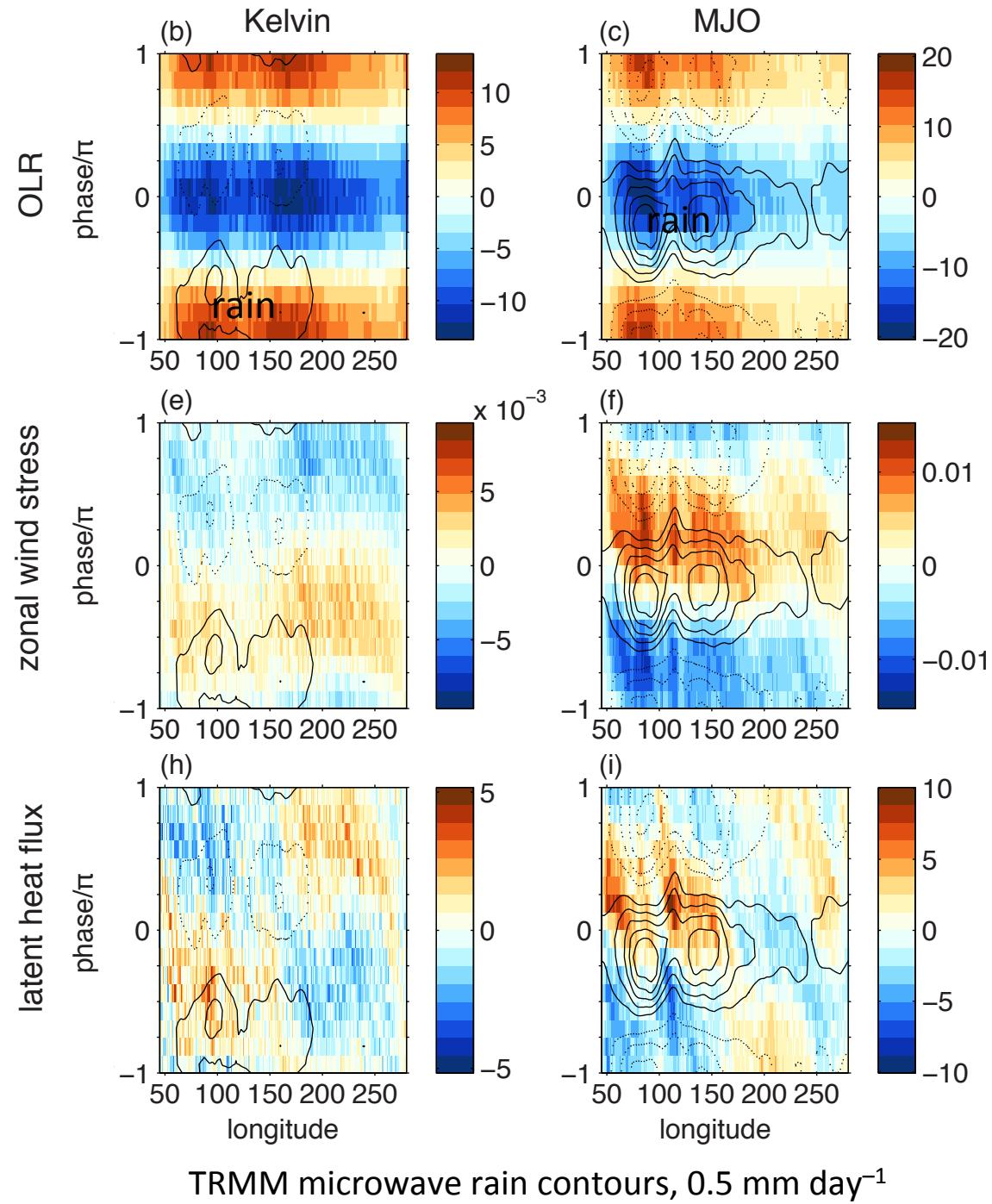
*Rain* leads OLR,  
especially in Kelvin  
waves. *Trailing cirrus?*

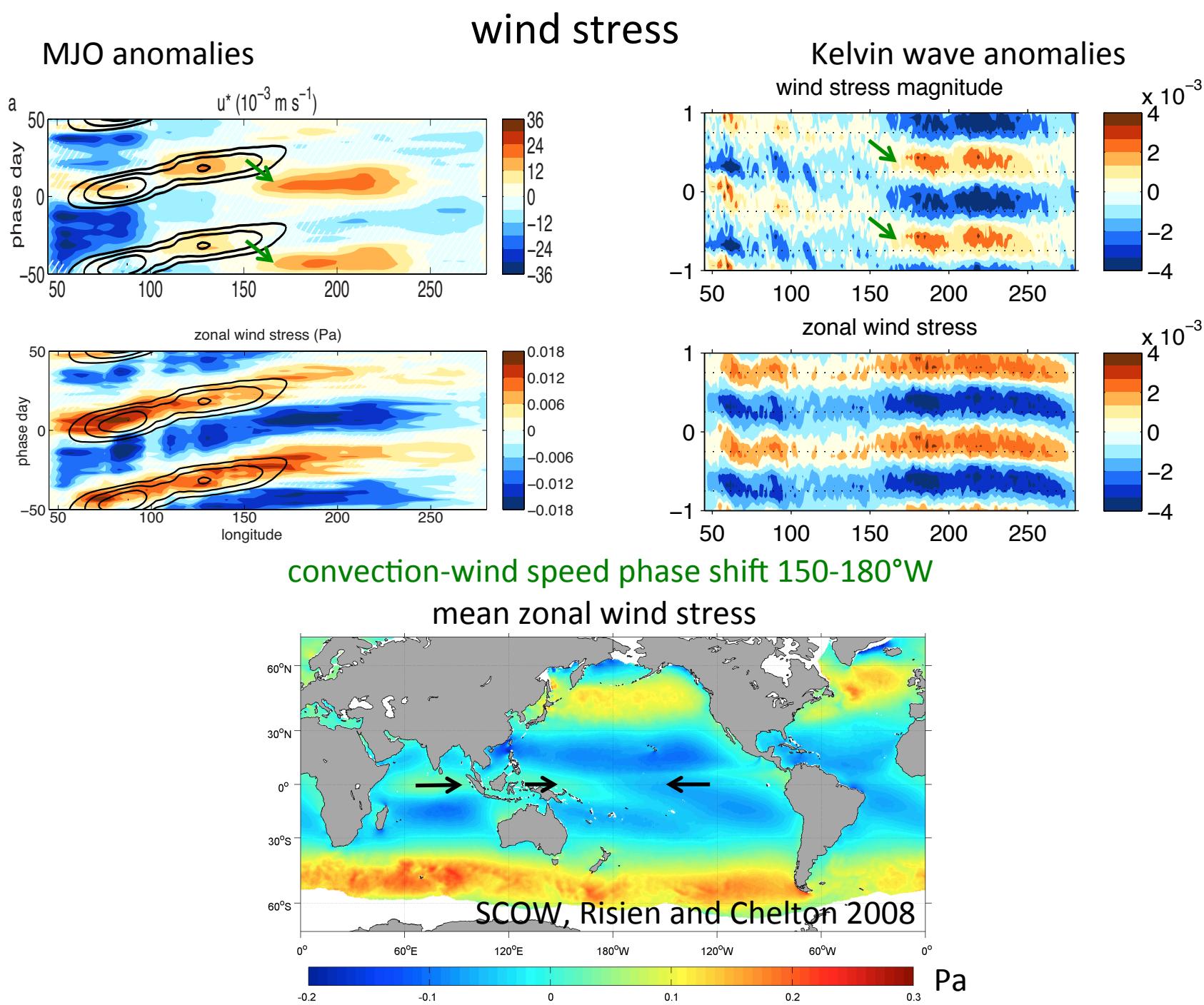
*Zonal wind* leads OLR  
in Kelvin wave;  
lags OLR in MJO.

*Latent heat* lags rain;  
sync. with zonal wind  
west, and opposed  
east of  $170^{\circ}\text{E}$ .

OLR relation to rain  
changes.

time →





# Summary

- Typical MJO convective events cool the ocean  
 $Q_{\text{net}}' = -40 \text{ W m}^{-2}$ .
- Stronger events observed in DYNAMO (and COARE).
- Uniform phase of surface response to convection from central Indian to west Pacific Ocean ( $80^{\circ}\text{E}-150^{\circ}\text{E}$ ).
  - transition  $150^{\circ}-180^{\circ}$  with reversal of mean wind stress.
- November 2011 MJO heating, moisture, wind bursts propagation and vertical structure like Kelvin waves.
- Surface fluxes in Kelvin waves are phased *differently* than intraseasonal oscillations.
- Precipitation not explained by local evaporation or column water storage
  - Requires anomalous horizontal moisture flux convergence.